Policy Research Working Paper 4786

Factors Affecting Levels of International Cooperation in Carbon Abatement Projects

Ariel Dinar
Shaikh Mahfuzur Rahman
Donald Larson
Philippe Ambrosi

The World Bank
Development Research Group
Sustainable Rural and Urban Development Team
November 2008

Policy Research Working Paper 4786

Abstract

The Clean Development Mechanism, a provision of The Kyoto Protocol, allows countries that have pledged to reduce their greenhouse gas emissions to gain credit toward their treaty obligations by investing in projects located in developing (host) countries. Such projects are expected to benefit both parties by providing low-cost abatement opportunities for the investor-country, while facilitating capital and technology flows to the host country. This paper analyzes the Clean Development Mechanism market, emphasizing the cooperation aspects between host and investor countries. The analysis uses a dichotomous (yes/no) variable and three continuous variants to measure the level of cooperation, namely the number of joint projects, the volume of carbon dioxide abatement, and the volume of investment in the projects. The results suggest that economic development, institutional development, the energy structure of the economies, the level of country vulnerability to various climate change effects, and the state of international relations between the host and investor countries are good predictors of the level of cooperation in Clean Development Mechanism projects. The main policy conclusions include the importance of simplifying the project regulation/clearance cycle; improving the governance structure host and investor countries; and strengthening trade or other long-term economic activities that engage the countries.

This paper—a product of the Sustainable Rural and Urban Development Team, Development Research Group—is part of a larger effort in the department to mainstream research on climate change. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at adinar@ucr.edu, shaikh.m.rahmnan@ttu.edu, dlarson@worldbank.org, pambrosi@WorldBank.org.

FACTORS AFFECTING LEVELS OF INTERNATIONAL COOPERATION IN CARBON ABATEMENT PROJECTS

Ariel Dinar[1], Shaikh Mahfuzur Rahman[2], Donald Larson[3], and Philippe Ambrosi[4]

[1] University of California, Riverside; at the time of this research World Bank, Development Economics Research Group. [2]Texas Tech University, Lubbock, and consultant to the World Bank. [3]World Bank, Development Economics Research Group. [4]World Bank, Carbon Finance Unit.
This paper is one of the products of the study "Local Actions for Global Impact Inference of the Role of the Flexible Mechanisms in Reducing GHGs" conducted in the World Bank DECRG-RU that was funded by the Knowledge for Change Trust Fund.
We thank Rama Chandra Reddy for useful comments.

1. INTRODUCTION

The Clean Development Mechanism (CDM)[2] has come a long way since its launch in Marrakech in 2001. As of December 31, 2007, 2,966 CDM projects have been submitted to the CDM Board for validation (UNFCCC, 2008). It is expected that by 2012, the transition year when the Kyoto Protocol terminates and a new protocol is reckoned to be in place, the CDM Board will have issued Certified Emission Reductions (CERs) equivalent to 800-1,150 million tons of CO_2 (UNDP, 2006:11). Of these, 42 percent represent partnerships between developed and developing countries.[3] This would be an impressive achievement, and it is believed and expected that the interest in CDM projects by governments and private sector entrepreneurs will extend beyond 2012. While the future of CDM depends on political decisions, it is also affected by the performance of that market, and by the fulfillment of the basic CDM objectives, namely greenhouse gas emission reductions that can be credited to the investor country and at the same time support sustainable development in the host country, as is discussed below. Thus, CDM projects provide a-priori incentives for cooperation between host and investor countries.

The potential of CDM has been studied by different disciplines, addressing different aspects such as efficiency, sustainability, institutions, and development. The views regarding the contribution of CDM towards the development objective are mixed. In a review of the literature on the (potential) impact of the CDM to sustainable development Olsen (2007:84) suggests that "…left to the market forces, the CDM does not significantly contribute to sustainable development." Sirohi (2007) arrives at a similar conclusion for the case of CDM project portfolio in India, but sees the prospect of CDM in developing the energy sector. Sirohi states that (p. 105) "The renewable energy projects may not be able to make any observable decline in the incidence of poverty … but they have immense importance in fostering development of energy resources in India" (that have indirect contribution to poverty reduction and growth). A similar conclusion is reached by Da Cunha et al. (2007) who attempt to assess the potential contribution of the CDM towards the achievement of MDGs in Brazil's remote regions. Their conclusion is that under certain conditions, such as improved market accessibility and synergy

[2] According to Article 12 of the Kyoto Protocol, CDM is designed as a regulated market with the premise of cooperation among the parties to the convention and the resulting anticipated payoffs to mitigation efforts involving Annex I and Non-Annex I countries.

[3] The remaining projects are presented to the Board "unilaterally" by the host country and do not necessarily involve foreign investors.

impact of other rural development policies, CDM projects could help minimize distortions in the access to clean energy resources in remote rural areas. However, Sutter and Parreno (2007:75) conclude that "… there are currently no UNFCCC registered CDM projects that are likely to fulfill the … twofold objectives … of emission reduction and contributing to sustainable development."

Despite the above skepticism, the number of CDM projects submitted to the Board has grown at an increased rate during the 5 years since this program started (Figure 1). Are there additional attributes that make the CDM attractive to both host and investor countries? From the perspective of the host countries (Annex I), investment in CDM projects can be seen as a means of development assistance, with all derived benefits to them. Thus, certain development attributes may play important roles in explaining levels of investment in CDM projects. Moreover, with the expectation that the demand for CERs would further increase beyond 2012, it would make sense to examine the factors that determine the location and extent of investment in CDM projects by investor countries. However, the CDM may face a loss of interest from carbon investors given the lead time required in developing and implementing a project. Without a clear signal from policy-makers on post-2012 prospects, the CDM may experience a significant slow down of activity in the near future (Cosbey et al., 2005).

With a development objective, CDM trends can be explained, using several supply-side variables such as export promotion, political hegemony, donor budget allocations, and donor internal politics, which are mainly political economy variables (Michaelowa and Michaelowa, 2007). But, CDM trends can also be explained using demand side considerations, where the developing countries formulate policies to Annex B countries' investment in CDM projects (Brechet and Lussis, 2006).

The literature summarizing the various carbon investment mechanisms and the development of Activities Implemented Jointly (AIJ), Joint Implementation (JI), and CDM projects over time is quite large. Larson and Breustedt (forthcoming) provide a detailed history and background work related to the pilot program of (AIJ) between 1992 and 2001. The history, status, and prospects of the CDM are articulated in detail in Lecocq and Ambrosi (2007) and in the references they list. And Larson et al. (1998) review carbon market policies and their recent development. These sources review the extensive literature on the nature and functioning of

CDM and the role regulation plays in its evolution. The literature in these sources allow comprehension of the relationship between global environmental agreement on climate and its actual operation in the real world and its relationship to the rest of the economy in terms of promoting low carbon growth.

In this paper we focus on identifying factors that affect levels of cooperation in carbon abatement projects between governments of Annex B (hereafter investor) countries and developing (hereafter host) countries. We focus on examining bilateral and multilateral CDM projects that were submitted to UNFCCC between 2003-2007 in order to provide useful assessment of policy interventions for possible enhancement and extension of the CDM mechanism beyond 2012. We are interested in understanding the grouping of countries in the CDM market, or in other words, what explains cooperation and cooperation level in CDM between certain dyads of countries. We model level of cooperation in CDM to explain incidence in projects between hosts and investor countries, and to understand why certain countries are heavily involved while others are not. We use also different measures of cooperation levels, including the number of joint CDM projects, the amount of CO_2 abatement in the CDM projects[4] and the level of investment in CDM projects.

The remainder of the paper is structured as follows. The next section provides the conceptual framework used for determining the cooperation level in joint CDM investment projects among host and investor countries. Section 3 presents the data sources, the assumptions and procedures used in variable construction, and the empirical specifications of the estimated relationships. The hypotheses regarding the relationship between the various variables in their different estimation contexts are spelled in Section 4. Estimation procedures and empirical results are presented in Section 5. Finally, Section 6 summarizes, highlights caveats, concludes, and addresses environmental and development policy implications.

2. Conceptual Framework

We look at CDM joint investment projects between two countries as a cooperative investment decision that is affected by both domestic factors and by economic and political interactions between these countries. We borrow from the literature on foreign direct investment (FDI), as

[4] Actually, investor country's ultimate interest is in project CER credits, while host country interest is in the investment in the project in their countries and the likely multiplier effect. Both interest lead to the CDM cooperation that we observe.

CDM is a subset of FDI. FDI stock or flow represent the level of cooperation among dyad states. We also rely on theories in the literature on international cooperation developed in the international relations and international economics literature, using variables that explain the level of other interactions between dyads of countries, and applied to the CDM market. In the remainder of the section we relate variables within these categories.

In general, the determinants of cooperation relate to the bilateral characteristics of the pairing – for example trade, or unilateral characteristics of the investor and the host – for example characteristics of their respective energy sectors. With this is mind, cooperation between a given country dyad *i* and *h* can be written as:

[1] $$C_{ih} = C(D_{ih}, \underline{I}_i, \underline{H}_h, \underline{I}_i \times \underline{H}_h)$$

where C is level of cooperation, D represents the bilateral characteristics of a given host-investor pair and $\underline{I}$ and $\underline{H}$ are vectors of variables strictly attributable to investor and host country *i* and *h*, respectively. We expect some interaction effects between *i* and *h* because certain variables in host countries are linked to considerations by investor countries.

The CDM raised expectations as it seeks to bridge technology gap between developing and developed countries. The Kyoto mechanisms are expected to serve as feedback loop for reducing economic and financial burden of host countries, which is expected to strongly reflect in the fast growing non-OECD countries. Furthermore, CDM is expected to evolve into a form of FDI with opportunities for collaboration for project developers in investor countries to interact with host country investors (UNEP/GRID-Arendal, 2000).

In order to analyze the level of engagement in CDM projects by investor and host countries, we apply the theory used for explaining FDI flows and stocks. Dunning (2002), Nonnemberg (2004), Nunnenkamp (2002), and Siegel et al. (2008) provide a wide review of theories used to support the empirical literature, linking variables in host countries and considerations by investor countries. While we include in this section a wide list of variables based on previous relevant work, we will restrict the set of variables we use in the empirical estimation of the level of cooperation to only variables that apply to both host and investor countries.

Several factors enhance investor and host country interest in CDM projects. According to Dunning (1996) the desire of firms in investor countries to seek foreign investments is affected by tax policy in the investor country; transaction cost in investor country and in the host country; and the size and status of the market for the particular product/technology transferred (for discussion on additional variables see Michaelowa and Michaelowa, 2007). In the case of the CDM market, one should also add the opportunity cost of meeting the Kyoto CO_2 reduction quota in the investor country. This depends on the country economy structure and growth trajectory, the energy dependency of the economy, the level of CO_2 emission of the economy, and the clean energy resources it possesses (Velasco, 2007; UNEP/GRID-Arendal, 2000).

Vulnerability to climate change and natural disasters an incentive for needed related actions has been well documented in the literature (e.g., Tsur and Zemel, 2008). Agents that that face harsher environmental conditions would be early adopters of technologies, implement policies, and look for partners to sign treaties to ease their situation, in the case of states sharing a water body (Dinar 2009).

But cooperation in the CDM market is not only dependent on country-specific variables. Joint investment in CDM projects, is a venture between international partners. Higher levels of joint investment indicate a higher degree of cooperation and no investment suggests no cooperation. Therefore, it is conceivable that international relations theories are likely to play some role alongside the profit maximization motives of the parties as in any international cooperation such as trade and FDI. We follow the literature on trade and FDI in the international conflict and cooperation literature (e.g., Polacheck et al., 2007; Dunning 2002). Below we provide the rationale behind each of the sets of the additional variables we include in the cooperation equation (e.g., trade and governance level).

International Trade

Several empirical studies argue that the extent of trade between countries provides an appropriate measure of their overall relations. Trade is a measure for both openness of a country to the global economy and the interaction between countries. The international relations literature's assessment of the link between trade, conflict, and cooperation has been quite mixed. On the one hand, there has been the general claim that increased trade between countries reduces incidents of militarized conflict between them and promotes peace (Russett and Oneal, 2001). The fear of losing the gains from trade deters conflict. Along the same lines, it has been argued that nations with cooperative political relations will engage in more trade, while conflictive nations are expected to trade less (Pollins, 1989). On the other hand, there has been the conjecture that high international trade, interdependence, and conflict are positively related (Waltz, 1979). Higher interdependence increases frictions among the countries, and therefore may lead to conflict. Barbieri (2002:121), for example, finds that the higher the interdependence and trade between countries the higher the likelihood of militarized conflict.

International trade also acts as a contract enforcing mechanism. Stein (2003), who argues that trade increases the likelihood of disputes between countries, also claims that it provides countries with an opportunity to resolve them at a lower level of international conflict. In essence, the coercive potential of trade reduces conflict, the occurrence of political crisis, and the need for militarized actions.

The above examination of the literature leads us to suppose that the level of relations among countries, measured by the extent of trade among them, is an appropriate measure for assessing the likelihood of cooperation negotiations (Neumayer, 2002). In particular, these studies suggest that the likelihood of a CDM will be relatively higher in the case of better or stronger relations among countries, and will be relatively lower in the case of poorer or weaker relations among countries (Sigman, 2004).

Enabling Environment: Governance, Regulations, Business Climate

When considering international cooperation, in general, and international investment in specific projects, in particular, domestic institutions may play a major role in either facilitating or inhibiting success of the cooperation-project in question. Dinar et al. (2007) suggest that political, legal, and economic institutions—enabling environment—often sustain the functioning of the state both domestically and internationally. It reflects not only the state's interest in the project but also its ability to enter into, and honor, an investment agreement, which may require financial investments and costs (Congleton 1992: 412-413). The political stability and enabling institutions of a given state are, therefore, a principal mode to judge the viability of its domestic institutions, its general inclination to negotiate a project agreement and its capacity to support the project.

Politically unstable countries have less institutional capacity to carry a project, and more politically stable countries may in turn have little interest in cooperative ventures with those. Similarly, investments are not secure and property rights poorly defined in unstable countries characterized by political turmoil (Deacon 1994). Participating in an agreement requires both competence (also in terms of appropriate investment climate and supporting regulation) and stability inherent in a particular polity, which will in turn be able to honor the signed project agreement (Young 1989:365; Young 1982:287).

Categories of Variables to Be Used in the Analysis

Based on the discussion in the literature, for the right hand side of the estimated relationship we will construct variables that represent variants of the level of economic activity; variables that represent the energy dependency; variables that measure the level of renewable energy endowments; variables that measure the cost of transactions; variables that measure vulnerability to climate change; variables that measure governance level; and variables that measure international trade among the host and investor countries. In addition, for level of cooperation we will calculate measures CDM incident and variables related to the CDM activities.

3. Data Description, Variable Construction, and Empirical Specification

Data used in this study are derived from several different sources. Collected data are then combined and transformed for the purpose of empirical analysis. In particular, individual CDM project-level data are combined with corresponding host and investor country-specific macroeconomic and environmental variables, and alternative empirical models are specified.

Description of Data and Variable Construction for the Empirical Analysis

A dataset consisting of all CDM projects that have been sent to UNFCCC for validation up until December 31, 2007 is obtained from the CDM/JI Pipeline Analysis and Database of the United Nations Environment Programme (UNEP) Risoe Center (2007). From December 2003 to December 2007, 2,966 CDM projects were sent to UNFCCC for validation. The dataset provides detailed information about each individual CDM project. That information includes project name, type, and current status, host country, expected emission reduction (ktCO2 per year and total CO_2 reduction up until 2012 and 2030), credit buyers, potential energy outputs, etc. The projects in the CDM pipeline are at various stages in the projects cycle. Of the nearly 3,000 projects, 1,966 are at validation, 806 are already registered, 42 were rejected (36) or withdrawn (6) and the rest are in various stages of evaluation. The dataset includes 1,246 (42%) unilateral projects, mainly in India, China, and Brazil, and 1,592 (54%) bilateral projects. The rest (128) are multilateral projects with 3-9 investor countries. Because our focus is on cooperation, unilateral projects are excluded from the analysis. We also drop projects that were withdrawn and four projects that include 5 or more country partners. For the remaining multilateral projects, project activities are equally divided and attributed to all plausible dyads. For example, for a CDM project with *n* investor countries, *n* separate dyads are formed with the same host. Amount of carbon abatement and capital costs are then equally divided and attributed to *n* investor countries in the dyads. However, one project is accounted for each of the *n* dyads because the single project is indivisible. We keep the projects that were subsequently rejected by the CDM board because they indicate propensity to cooperate, which is the subject of this paper. For a subset of projects (1199), we also have information about capital costs (Seres 2007).[5]

For the empirical model, we construct four measures of cooperation from this basic data for pairs of countries i and h. We first use a dichotomous variable to distinguish between pairs that do have joint CDM projects and pairs that do not have any project at all. The variable CDM Incidence (*CDMI*) will get a value of 0 if there is not CDM activity among the countries and a value of 1 if the number of CDM projects is greater than 0. Then we measure the cooperation level, using three variables, namely, Number of Projects (*NPRJ*), Total CO_2 Abatement (*Total CO2 Abatement*) in million tones of Certified Emissions Reduction (CER) of CO_2 equivalent and Volume of Investment (*VINV*) in million constant US dollars. When direct information on project costs is missing (we have only 1199 projects with direct investment cost data), we categorized projects by type (9 types) and size (2 sizes: small and big) and calculated for each and average investment cost value. We then used average investment cost to extrapolate to projects for which we did not have investment cost data.

As discussed in the context of equation 1, we use both pair-wise and country characteristics as determinants in our statistical models. For the bilateral measure, we use the level of bilateral trade among the countries (*TRD*). We also include five additional country characteristics for both host and investor: i) the economic development of the countries

[5] See Appendix 1 for details.

(measured in either *GDP*, or *ENR*), ii) the energy sources status (*REN*), iii) climate vulnerabilities of the countries (*IVUL*), iv) governance level of the countries (*GOVR*), and v) Ease of Doing Business in the countries (*EDB*).

While we use only six groups of right hand side variables, we still need to calculate some of them, and the dependent variable, using additional variables. Therefore, we report here all data we have used and which variables have used which variables in their construction. Annual GDP (both in current and 2000 constant US$ absolute and per capita terms), energy and electricity production, import, and consumption (both in absolute and per capita terms), and the volume of CO_2 emissions (in terms of total kiloton of oil equivalent, per capita CO_2, and CO_2 per dollar of 2000 PPP GDP) data for all countries of the world during 1960-2003 are obtained from the World Development Indicators (WDI, World Bank, 2007).[6] In addition, country level estimates of total energy available from nonrenewable sources (e.g., coal, oil, gas, oil shale, and bitumen) and annual energy available from renewable (e.g., solar, onshore and offshore wind, hydro, geothermal, and biofuels) sources are obtained from Buys et al (2007).

These data are used to construct variables reflecting economic development, available energy resources, and emission intensity of the host and investor countries. Economic development variables include *Total GDP* (*GDP_TOT*), *Average GDP* (*GDP_AVG*), and *GDP per Capita* (*GDP_PC*). Energy resources of each country are constructed by adding up potential non-renewable and renewable energy resources and are represented by two variables: *Nonrenewable Energy* (*NREN*) and *Renewable Energy* (*REN*). In addition, two separate variables are constructed to reflect intensity of energy use in each country: *Avr Annual Energy Use* (*ENR_AVG*) and *Annual per Capita Energy Use* (*ENR_PC*). See Appendix 3 for further detailed description of the variables considered for this study and their specification.

Buys et al (2007) provide measures for countries' vulnerability to climate change and emissions reduction mandates. They first construct individual indices for alternative sources of vulnerability and then calculate composite index values by categorizing the sources of vulnerability into two major groups: impact and source vulnerabilities. We use the first one in our empirical analysis. Impact vulnerability refers to the country's ability to sustain climate change impacts such as weather damage and sea level rise. The quantitative score (scale of 1 to

[6] Data on CO_2 per dollar of 2000 PPP GDP were not available prior to 1975.

100) of the *Impact Vulnerability* (*IVUL*) for the host and investor countries of the CDM projects are obtained from Buys et al (2007) and used in our empirical analysis.

Estimates of six dimensions of governance of the host and investor countries are obtained from Kaufmann et al (2007). The six dimensions of governance are: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. Kaufmann et al estimate these dimensions of governance of 212 countries during the period of 1996-2006 based on several hundred individual variables measuring the perceptions of governance reflecting the views of public sector, private sector and NGO experts, as well as thousands of citizen and firm survey respondents worldwide. Kaufmann et al (2007) aggregate these individual measures into the above six categories, using a statistical methodology known as unobserved components model. In particular, they first rescale the individual indicators from each underlying source in order to make them comparable across data sources. Then they construct a weighted average of each of these rescaled data sources to construct the aggregate indicators of governance. The weights they assign to each data sources are based on the estimates of the precision of each source that are produced by the unobserved components model. Combining the six governance measures of Kaufmann et al. (2007), a *Governance* variable (*GOVR*) is constructed, using a Principal Component Analysis (PCA) that reflects overall governance level of the host and investor countries of each of the CDM projects.

We used the ease of doing business (EDB) indicators as a proxy for the transaction costs associated with the CDM projects implementation. EDB indicators, comparing business regulations and protection of property rights across 178 countries and over time are obtained from World Bank (2008). The EDB index ranks economies from 1 to 178 by measuring regulations affecting 10 stages of a business's life: starting a business, dealing with licenses, employing workers, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts, and closing a business. The index reflects the ranking of simple average of country percentile rankings on each of the 10 topics, with a higher rank indicating less favorable business atmosphere. The ranking on each of the 10 topics is the simple average of the percentile ranking on its component indicators.[7] The rankings remain almost the

[7] The choice of aggregation method has little influence on the ranking. More complex aggregation methods such as principal components and unobserved components yield nearly identical rankings (Djankov and others, 2005).

same over the years, from 2003 to 2007. However, a simple average of the rankings over the years is used to calculate the overall *Ease of Doing Business* (*EDB*) in each country.

Data on annual bilateral trade between all countries in the world are obtained from International Monetary Fund (IMF, 2007), for the period of 1960-2003. Using the sum of the volumes of bilateral trade and *GDP* (in current US$) of the host and investor countries, two alternative trade variables, *Trade*1 and *Trade*2 (TRD_1 and TRD_2) are constructed following Dinar et al (2007).[8] The first trade variable (TRD_1) expresses total trade (the sum of the volume of bilateral imports and exports) between the host and investor countries as a fraction of the sum of the countries' GDPs. The second trade variable (TRD_2) measures the total trade (the sum of the volume of bilateral imports and exports) between the host and investor countries as a fraction of their trade with the rest of the world.[9] TRD_1 is referred to as trade importance and TRD_2 is referred to as trade dependency. For a group of $N \geq 2$ countries the TRD_1 and TRD_2 (*Trade*1 and *Trade*2) are:

$$[2]\ TRD_1^{\{1,\ldots,N\}} = \frac{\sum_{t=1}^{T}\left\{\sum_{j=1}^{N}\left(IMP_{jkt} + EXP_{jkt}\right)\right\}}{\sum_{t=1}^{T}\sum_{j=1}^{N}\left(GDP_{jkt}\right)}, \quad \forall\, k \in N;\ j \in N;\ k \neq j$$

$$[3]\ TRD_2^{\{1,\ldots,N\}} = \frac{\sum_{t=1}^{T}\left\{\sum_{j=1}^{N}\left(IMP_{jkt} + EXP_{jkt}\right)\right\}}{\sum_{t=1}^{T}\left\{\sum_{j=1}^{N}\left(IMP_{jwt} + EXP_{jwt}\right)\right\}}, \quad \forall\, k \in N;\ j \in N;\ k \neq j$$

Where *IMP* and *EXP* are import and export, respectively, *t* is year, *w* is the rest of the world, not including any country *j* and *k* in *N*.

---

[8] The definitions of these variables are available in Dinar et al (2007). Since the IMF trade data are in current $US; country-level GDP in current $US (collected from the WDI of the World Bank) are used to construct the trade variables.

[9] For multiple investor countries, TRD_1 expresses trade as the sum of total volume of exports and imports between the host country and each investor country as a fraction of the sum of GDP of each of the country involved in the CDM project. On the other hand, TRD_2 measures the total trade (the sum of the volume of bilateral imports and exports) between the host and each investor country as a fraction of their trade with the rest of the world.

4. HYPOTHESES

We selected a particular set of variables for inclusion in the regression analysis. These variables were selected because, at least theoretically, each can be attributed to explaining both investor and host countries' desire to cooperate. From the above discussion and based on previous work on FDI and AIJ determinants that resemble behavioral patterns similar to those of CDM (e.g., Agarwal, 1980; Dunning 2002; Nonnemberg et al., 2005; Nonnenkamp 2002; and Larson and Breustedi, 2007), it is reasonable to hypothesize that, while all other variables are held constant, CDM incident and the level of cooperation between host and investor countries will increase (decrease) with higher (lower) level of economic development; will increase (decrease) with higher (lower) levels of energy use, and thus emission intensities, of its economy. We hypothesize that for an investor country the level of cooperation will decrease (increase) and for host country it will increase (decrease) with more renewable energy resources available in that country; And the more (less) vulnerable to climate change the economies are, the higher (lower) will the cooperation be.

Additional variables included in the empirical models are trade, business environment, and governance. Based on our conceptual framework we expect that CDM incidence and the level of cooperation between host and investor countries will increase (decrease) as trade widens (shrinks); will decrease (increase) as transaction cost of doing business are higher (lower); will increase (decrease) as governance level in the country increases (decreases); will increase (decrease) as vulnerability level in the country increases (decreases); will increase (decrease) as development level in the country increases (decreases); and will decrease (increase) as renewable energy resource levels in the country are higher (lower).

To be specific, we expect $\partial C_i / \partial TRD > 0$, $\partial C_i / \partial GOVR > 0$, $\partial C_i / \partial IVUL > 0$, $\partial C_i / \partial GDP > 0$, $\partial C_i / \partial EDB < 0$, $\partial C_i / \partial REN < 0$, where C_i is the cooperation variant (*i=CDMI*, *NPRJ*, *VINV*, *TCO2*).

This paper focuses on a relatively narrow set of hypotheses, mainly related to the cooperation aspect of CDM. Additional hypotheses could be about the growth pattern of CDM and whether or not it is affected by the regulation of the carbon product. For example, does growth of CDM follow the same trend as the international trade/FDI between countries or does it follow a curtailed growth path considering the strong role of regulation in approving the carbon assets for trade in CDM. This and similar hypotheses are very relevant and will be addressed in a different paper.

5. Estimation Procedures and Results[10]

Depending on the characteristics of the dependent variables, appropriate econometric procedures are applied to estimate the incidence and level of CDM cooperation according to the models specified above. The incidence of host and investor countries in CDM activity is represented by a dichotomous variable indicating whether a particular dyad has any CDM activity (the dependent variable is set equal to 1 for those dyads having CDM activity and equal to 0 for those without any CDM activity). The probability that host and investor countries will jointly engage in CDM activity is estimated by regressing the characteristics of the host and investor countries and dyads on the dichotomous variable. Both logit and probit models are employed to estimate the probability.

As described earlier, the level of CDM cooperation between host and investor countries is represented by three alternative measures: the number of CDM projects, amount of CO2 abatement, and volume of capital investments. When the level of cooperation (the dependent variable) is measured by the number of CDM projects (i.e., *NPRJ*), Poisson regression models are estimated. In this case, the *i*th observation on *NPRJ* is assumed to be a conditional draw from a Poisson distribution, the natural logarithm of the mean of which is a linear function of explanatory variables. Maximum likelihood estimates are calculated using the density function of the Poisson distribution with equal mean and variance.

Dependent variables representing total carbon abatement (*TCO2*) and volume of investment (*VINV*) have observations at 0, corresponding to dyads that do not cooperate in CDM activity. The OLS estimates based on such a censored sample are likely to be biased. Since values of explanatory variables are also available for the countries not participating in the CDM activity, a tobit model is appropriate that determine both the probability of participating in the CDM activity and the levels of *TCO2* and *VINV* when these are positive. (See Appendix 2 for definitions of variables used in the regression analyses.) Several specifications of the Poisson and tobit models are examined.

[10] See Appendix 2 for variable definition.

Descriptive Statistics Results

We start by providing a descriptive statistics of project-level variables. Note that we created more variables than we use in the regression analysis because of the interest these variables create. Those variables are not given acronyms. We then move to describe country-level and project-related variables, both for host and investor countries. Finally we provide descriptive statistics of main variables for the dyad-level variables.[11]

Project Level

Table 2 includes the descriptive statistics for variables in the project-level dataset. In this table we include all reported projects, including unilateral ones. Some additional descriptive results may be of interest. There are 2966 projects that have been submitted to the UNFCCC. Of these, 1966 are at validation, 806 are already registered, 42 were rejected (36) or withdrawn (6) and the rest are in various stages of evaluation. The dataset includes 1246 (42%) unilateral projects, mainly in India, China, and Brazil, and 1592 (54%) bilateral projects. The rest (128) are multilateral projects with 3-9 participating countries. We dropped the projects that were withdrawn and the projects that include 5 or more country partners (4). We kept the projects that were rejected because they indicate propensity to cooperate, which is the subject of this paper. Therefore our dataset includes 2956 project observations. Eighty two percent of the projects are associated with power generation; 37 percent create hydro, solar and wind energy; and 29 percent create energy from agricultural biomass. Project life ranges between 7 and 30 years. Mean investment per 1,000 tons of CO_2 abatement is $38,004. Mean electricity generation capacity per project is 31.2 Mwh. And mean per annum abatement of CO2 is 140.6 kiloton of oil equivalent.

Country Level

In the dataset there are 170 host countries (including island countries) and 36 investor countries, many of which are involved in CDM investment. We present the data separately for the host and for the investor countries, in Tables 3 and 4, respectively.

[11] It is important to note that project-level and country-level descriptive statistics results are reported for all available observation in each category while dyad-level descriptive statistics are reported only for the observations included in the regression analysis.

The mean number of projects per host and investor country is 17 and 54, respectively, but it varies between 0 and 960 for host countries and 0 and 720 for investor countries, (Note that India and China host many projects that are funded by local investors.) Mean values of governance in host countries are quite low with a mean of -2.49. Source vulnerability for host and investor countries are quite similar (56.25 and 55.93 respectively), but host countries are much more vulnerable than investor countries 49.95 and 27.50, respectively). Some of the variables deserve a mention. First, mean sample values suggest that CO_2 per capita abatement levels of host countries are about 50 percent of investor country levels. A similar value was found for GDP per capita and energy per capita. Finally, mean per capita values for nonrenewable energy resources are about 400 times higher for host countries, while they are only 14 times richer in renewable energy resources per capita than investor countries.

Dyad Level

With 34 investor countries (excluding Australia and the USA) and 175 host countries, there are 5,950 plausible host-investor pairs.[12] Only 195 of the host-investor pairs have CDM project activity, while 46 host countries have unilateral projects. Unilateral CDM projects were removed from the dyad-level analysis. Dyads without any CDM projects can be regarded as the non-cooperation dyads. Because we use 3 different left-hand side variables the missing values problem results in different sample size for each dependent variable and making it harder to compare the results. Therefore, we use only 2,771 dyad-level observations that allow comparisons among the various dependent variables.

The descriptive statistics of dyad-based variables used in our analysis are presented in Table 5. *Annual CO2* abatement level values are nearly 113 kilotons, ranging between 0 and nearly 89,793 kilotons. *Annual Volume of Investment* cost (*VINV_YR*) values are $19.6 million, and mean trade ratio values are 0.00037 and 0.00090 for *TRD1* and *TRD2* respectively. The independent variables are presented for host and investor country, separately. The interaction variables (host × investor) are not presented. Several results are worth mentioning. First, we note main differences in the various variables between host and investor countries in the dyads.

[12] Australia and the USA are excluded from the dataset because Australia did not ratify Kyoto until 2005 and the USA is yet to ratify Kyoto. Few host countries are also omitted from the dataset because they are very small and country-level data are not available for those. (Our descriptive statistics in Table 3 includes Australia which brings the number of Dyads to 6125.)

Investor countries have higher *Average GDP*, higher *Average Annual Energy Use*, better ranking of *Ease of Doing Business*, better *Governance*, and lower *Impact Vulnerability.* However, host countries have significantly much higher endowments of *Renewable Energy* than do investor countries. As was hypothesized, earlier, we expect that this difference is attractive to investor countries.

Results for the Cooperation Estimates

To reduce complications associated with having the dyad as the observation unit, our variables capture the bilateral nature of the dyad. All variables incorporate values for the two countries in the dyad that are engaged in the CDM activity. In the case of all other variables except Trade, we use values for host, for investor, and the interaction between investor and the host country. In the case of Trade, we have two variants and both incorporate the values of the host and investor countries into the variable.

We present results for a set of 2,771 country dyads that have all the needed data in all the regression specifications. We also report, in Appendix 3, the results of regressions that have a larger number of observations due to availability of data. All our equation estimates (Tables 6-9) have significant fit with Likelihood Ratio values that are significant at the 1 percent level in all estimates.

Results are presented in Table 6 for the dichotomous *CDM Incidence* (*CDMI*). For both the logit (column 1) and probit (column 2) estimation procedures results are as expected. Higher economic development levels measured as *Average annual energy use* (*ENR_AVG*) of both host and investor countries are significant and positive; *Governance* level (*GOVR*) and impact vulnerability (*IVUL*) are both significant and positive. The trade variable (TRD_1) is positive and significant. The *Ease of doing business* (*EDB*) behaves also as expected with a negative and significant sign assigned to the host country and an insignificant coefficient assigned to the investor country. The *Renewable Energy* (*REN*) endowment of the host country has a positive and significant coefficient and that of the investor country has a negative and significant one. In column 3 of Table 6 we present also the marginal effect calculated at the sample mean as the change in the probability for an infinitesimal change in each independent. The marginal effect of bilateral trade has by far the highest impact, where a 1 percent change in dyad trade increases the likelihood of CDM incidence by close to 5%. All other independent variables are much less effective but among them governance has the highest effect.

Results are presented in tables 7, 8, and 9 for the 3 variants of level of cooperation, namely number of projects (*NPRJ*), CO_2 abatement (*TCO2*) and volume of investment (*VINV*), respectively. Most interaction terms are statistically insignificant. In all functional forms, all country economic development variables (*GDP_AVG*; *ENER_AVG*) are positive and have a significant sign, meaning that more cooperation is expected as both the investor and the host countries are more developed. Renewable energy profile of the *RENRG* variable is significant in all regressions. It is positive in the case of a host country (*hst_RENERG*), while it is negative in the case of the investor country (*inv_RENRG*). This suggests that renewable energy resources operate in opposite directions in host and investor countries, which is consistent with the relevant hypothesis. For a host country, abundant renewable resources imply more CDM project to offer. For an investor country, abundant renewable resources imply opportunities to invest in carbon abatement projects at home and less incentive for investments abroad.

Ease of Doing Business (*EDB*) has the expected negative and significant coefficients in estimates for both host and investor countries in Table 6 where the dependent variable is the number of projects (*NPRJ*). It has expected negative and significant coefficients for the host country (*hst_EDB*) in the cases of the other two dependent variables, *TCO2* and *VINV* (Table 7 and 8). However, it has a non-significant coefficient for the investor country in these two tables. Our interpretation is that EDB is a very important consideration in host countries for CDM investment. It is less important in the case of investor countries. It is important to indicate that higher levels of that variable mean more difficulty of doing business in that country.

Governance (*GOVR*) is also an important variable in our analysis. It has positive and significant coefficients for *inv_Governance* variable in all equations, and positive, but not significant coefficients for the *hst_Governance* variable in several equations. Better governance leads to higher cooperation. The coefficient of the impact vulnerability variable (*IVUL*) was positive and significant, as expected, in all estimated regressions for both host and investor countries. This means that the higher the vulnerability level of the country, either a host or an investor, the more it will be willing to cooperate in CDM investment for different reasons. For a host country such cooperation means improvement of its development opportunity, and for an investor country this means a lower cost of meeting its CO_2 reduction obligations, and a long-term contribution towards reduction of GHGs.

6. Summary, Conclusions and Policy Implications

In this paper we analyzed the CDM market from the point of view of cooperation between developing (host) and developed (investor) countries. We used a dichotomous variable to measure incidence of country involvement in CDM projects and three variants to measure cooperation level, namely number of joint CDM projects, volume of CO_2 abatement that can be realized from the CDM projects, and volume of investment in the CDM projects. All cooperation equation estimates provided robust and consistent results, for all four cooperation variants. We used linear functional forms in the independent variables. We used linear and log transformation for the investment variable. Our results suggest that the variables we used – namely economic development, institutional development, energy structure of the economies, level of country vulnerability to various climate change effects, and international relationship between the host and investor countries – are good predictors of the level of cooperation in CDM projects we may expect. Coefficients of the interaction terms of these variables between the host and investor countries, in most cases, have not been significant.

In deriving conclusions from the analysis, we will start by comparing our results to those of other studies that attempt to explain the level of cooperation between countries. We used trade to explain the level of cooperation in CDM projects. The two trade variables we constructed suggest that countries with strong trade relations, that imply also other types of international relations ties, will be more likely to cooperate over CDM projects. Trade was found in many other studies to be a key in explaining cooperation in water treaties and in FDI. Trade is only an example of economic ties among the dyad countries. Therefore, the overall conclusion is that any type of active relationships among the dyad countries would lead to higher likelihood of cooperation over CDM.

Another variable that has similar impact in other studies of international cooperation is the level of governance in the country. It is frequently suggested that governance matters and that institutional strength is a prerequisite for better performance, both domestic and international. Other studies that were reviewed earlier suggest as well that higher level of governance makes countries better parties for cooperation over many issues. A similar interpretation can be attributed to the variable measuring ease of doing business. Our results suggest, as it is expected, that the situation in the investor country does not matter. What matters is the level of ease of doing business in the host country. The more difficult it is to do business in a host country, the less it will attract domestic and international investors. It is quite straightforward, but needed empirical proof. Studies on FDI demand and supply identified ease of doing business in the investor (source) country to be negatively correlated with FDI supply. This was explained by having local entrepreneurs in developing countries look for other markets because they can minimize their transaction cost of doing business at home. Our results suggest the same impact only in the case of using the number of projects as an indicator for the level of cooperation. In other cases this variable's coefficient was not significant.

All other variables measure the natural endowment of a country and thus may be less affected by policy interventions. Our policy discussion would therefore be focused only on the suggestion that international development institutions focus mainly on the strengthening of multilateral interactions between countries and on domestic structural changes and reforms to economies, so that they are better prepared not only to adapt to climate change but also to be able to better cooperate in the CDM market and take advantage of the CDM dividend—development—that results from CDM joint investment.

There are several variables in the cooperation equation specification that are state variables in the sense their level cannot be controlled, at least directly, by policy makers. This leaves the range of policy interventions narrower. Still, *Governance* and *EDB* leave sufficient degrees of freedom to policy makers. One issue that has been raised in Carbon Finance discussions is the complications of the CDM project clearance process, which becomes a barrier to CDM project development. Simplifying the CDM project clearance cycle is an important policy option. *EDB* goes hand in hand with *Governance* although they are not necessarily correlated. Improved governance in the host and in the investor countries means higher political stability and trust between the countries for business. Finally, trade or other long-term economic activities that connect the countries is an important inhibitor for CDM cooperation. Having a regional or international trade agreement or the like will increase the likelihood of CDM incidence and higher level of cooperation on CDM projects.

Thus, all three variables, *EDB*, *Trade*, and *Governance* have a significant impact, increasing future viability of the CDM market. These variables represent both state-level and international-level policy interventions, which governments and international development institutions have already identified as important directions for their future commitment. The analysis in this paper further highlights and quantifies these declared commitments.

REFERNCES

Agarwal, Jamuna P. (1980). "Determinants of Foreign Direct Investment: A Survey." *Weltwirtschaftliches Archiv* 116: 737–773.

Barbieri, Katherine, 2002. The Liberal Illusion: Does Trade Promote Peace? Ann Arbor, MI: The University of Michigan Press.Barbieri (2002

Brechet, Thierry and Benoit Lussis (2006). "The Contribution of the Clean Development Mechanism to National Climate Policies." *Journal of Policy Modeling* 28:981-994, 2006.

Buys, Piet, Uwe Deichmann, Craig Meisner, ThaoTon That, and David Wheeler (2007). "Country Stakes in Climate Change Negotiations: Two Dimensions of Vulnerability." World Bank Policy Research Working Paper No. 4300, Washington, D.C.

Chakrabarti, Avik (2001). "The Determinants of Foreign Direct Investment: Sensitivity Analyses of Cross-Country Regressions." *Kyklos* 54(1): 89-113.

Congleton, Roger, 1992. 'Political Institutions and Pollution Control', Review of Economics and Statistics 74: 412-421.Congleton 1992

Cosbey, Aaron, Warren Bell, Deborah Murphy, Jo-Ellen Parry, John Drexhage, Anne Hammill, and John Van Ham (2005). "Which Way Forward? Issues in developing an effective climate regime after 2012. Winnipeg: International Institute for Sustainable Development.

Da Cunha, Kamyla Borges, Arnaldo Walter and Fernando Rei (2007). "CDM Implementation in Brazil's Rural and Isolated Regions: The Amazon Case." *Climatic Change* 84:111-129.

Dinar, S. A. Dinar and P. Kurukulasuriya, SCARPERAION: An Empirical Inquiry into the Role of Scarcity in Fostering Cooperation between International River Riparians. World Bank Policy Research Working Paper No. 4294, Washington, D.C., 2007.Dinar et al. (2007)

Dinar, Shlomi, (2009). "Scarcity and Cooperation along International Rivers", *Global Environmental Politics* 9(1), forthcoming.Dinar 2009

Dunning, John H (1993). "Multinational Enterprise and the Global Economy." Wokinghan: Addison-Wesley.

Dunning, John H. (1996). “The role of FDI in a globalizing economy,” in C. J. Green and T. L. Brewer (eds.), Investment Issues in Asia and the Pacific Rim, New York: Oceania, 43-64.

Dunning, John H. (2002). “Determinants of Foreign Direct Investment: Globalization Induced Changes and the Role of FDI Policies,” Background Paper for the Annual Bank Conference on Development Economics held in Oslo, World Bank, Washington, D.C. Dounloadabel at http://wbln0018.worldbank.org/eurvp/web.nsf/Pages/Paper+by+Dunning/$File/DUNNING+1.PDF (August 22, 2007).

International Monetary Fund (2007). Direction of Trade data http://www.imfstatistics.org/dot/.

Kaufmann, Daniel., Aart Kraay, and Massimo Mastruzzi (2007). “Governance Matters VI: Aggregate and individual governance indicators 1996-2006,” World Bank Policy Research Working Paper No. 4280, Washington, D.C.

Larson, Donald F. and Gunnar Breusted, (forthcoming). Will markets direct Investments under the Kyoto Protocol? Lessons from the Activities Implemented JointlyPpilots. *Environmental and Resource Economics*.

Larson, F. Donald, Philippe Ambrosi, Ariel Dinar, Shaikh Mahfuzur Rahman and Rebecca Entler (2008). “A review of Carbon Market Policies and Research”. *International Review of Environmental and Resource Economics* (In Press).

Lecocq, Franck and Philippe Ambrosi (2007). The Clean Development Mechanism: history, status, and prospects. Review of Environmental Economics and Policy 1(1), 134-51.Lecocq and Ambrosi (2007)

Michaelowa, Axel and Katharina Michaelowa (2007). “Climate or Development: is ODA Diverted from its Original Purpose?” *Climatic Change* 84:5-21.

Neumayer, Eric, (2002). ‘Does Trade Openness Promote Multilateral Environmental Cooperation?’ World Economy 25: 815-832.Neumayer, 2002)

Nonnemberg, M., Bragaand Mario, and J.C. de Mendonça (2005). "The Determinants of Foreign Direct Investment In Developing Countries." Estudos Econômicos, Sâo Paulo, 35(4):631-655. Also at http://ideas.repec.org/p/anp/en2004/061.html (August 22, 1007).

Nunnenkamp, Peter (2002). "Determinants of FDI in Developing Countries: Has Globalization Changed the Rules of the Game? Kiel Working Paper No. 1122, Kiel Institute for World Economics, Kiel.

Olsen, Karen Holm (2007). "The Clean Development Mechanism's Contribution to Sustainable Development: A Review of the Iterature." *Climatic Change* 84:59-73.

Polacheck, Solomon W., Carlos Seiglie, and Jun Xiang (2007). "Globalization and International Conflict: Can FDI Decrease Conflict?" Paper presented at the ASSA Meeting, Chicago, IL, January 5-7.

Pollins, Brian (1989). 'Conflict, Cooperation, and Commerce: The Effect of International Political Interactions on Bilateral Trade Flows', American Journal of Political Science 33: 737-761.Pollins, 1989

Russett, Bruce and John Oneal (2001). Triangulating Peace: Democracy, Interdependence, and International Organizations. New York, NY: W.W. Norton & Company.Russett and Oneal, 2001

Seres, Stephen (Climatesolutions.ca), (2007). Data Processing of capital cost in CDM Projects.

Siegel, Jordan I., Licht, Amir N. and Schwartz, Shalom H., 2008. "Egalitarianism, Cultural Distance, and FDI: A New Approach." (January 2, 2008). Available at SSRN: http://ssrn.com/abstract=957306

Sigman, Hillary (2004). 'Does Trade Promote Environmental Coordination? Pollution in International Rivers', Contributions to Economic Analysis and Policy 3:Article 2.Sigman (2004)

Sirohi, Smita (2007). "CDM: Is it a 'Win-win' Strategy for Rural Poverty Alleviation in India?" *Climatic Change* 84:91-110.

Sutter, Christophe and Juan Carlos Parreno (2007). "Does the Current Clen Energy Development Mechanism (CDM) Deliver its Sustainable Development Claim? An Analysis of Officially Registered CDM Projects." *Climatic Change* 84:75-90.

Tsur, Yacov and Amos Zemel, 2008. Regulating Environmental Threats. Environmental and Resource Economics, 39: 297-310.

UNDP United Nations Development Program (2006). An Assessment of Progress with Establishing the Clean Development Mechanism. New York: UNDP.

UNFCCC (2008). Clean Development Mechanism (CDM) http://cdm.unfccc.int/index.html, (accessed October 18, 2008).

United Nations Environment Programme (UNEP) Risoe Center (2007). CDM/JI Pipeline Analysis and Database, http://cdmpipeline.org (accessed November 6, 2008).

United Nations Environmental Program UNEP/GRID-Arendal, (2000). Methodological and Technological issues in Technology Transfer. Accessed on the web at http://www.grida.no/climate/ipcc/tectran/index.htm (accessed on July 29, 2007).

Velasco, Ana Pueyo (2007). Variables Underpinning Technology Transfers Through the CDM. Joint Implementation Quarterly, 13(3):5-6.

Waltz, Kenneth (1979). Theory of International Politics. New York, NY: McGraw-Hill.Waltz, 1979

WDI, The World Bank (2007). World Development Indicators, http://publications.worldbank.org/WDI.

World Business Council for Sustainable Development (1998). Technology Cooperation for Sustainable Development. Position Brief, Geneva (accessed on June, 2007).

Table 1: Correlation Matrix for Dependent Variables Used in the Cooperation Equations

	NPRJ	*TCO2*	*VINV*	*TCO2YR*
Number of Projects	1			
Total CO2 Abatement	0.812	1		
Volume of Investment	0.913	0.946	1	
Total CO2 Abatement per year	0.757	0.995	0.919	1
Annual Investment cost	0.870	0.961	0.993	0.945

Table 2: Project-level descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Annual CO2 abatement (ktCO_2e)	2956	140.64	487.32	4	10437
Total CO2 abatement during project life (ktCO_2e)	2956	1120.42	3583.17	3.5	73059
CDM-based electricity generation capacity (MW)	2474	31.20	100.09	0	1560
Investment cost[a] (US$)	1199	3.31E07	6.22E07	7222	7.87E08

Notes: [a]All monetary values in this paper are 2000 constant US$.

Table 3: Country-level descriptive statistics (Host countries)

Variable	Obs	Mean	Std. Dev.	Min	Max
Number of projects	175	16.89	99.53	0	960
Annual CO2 abatement ($ktCO_2e$) [a]	175	2375.75	18177.86	0	233211
Total CO2 abatement during project life	175	18925.58	137625.67	0	1735068
Annual investment cost (Mill. US$)	175	20.6	133	0	1570
Total investment cost (Mill. US$)	175	182	1230	0	14900
Annual GDP (Mill. US$ Const. 2000)	153	42100	122000	4390	17900000
GDP per capita (Constant 2000 US$)	152	3383	5139	101	23903
Climate change impact vulnerability	170	49.95	21.45	1	91.28
Governance	116	-2.40	4.96	-14.12	11.34
Ease of Doing Business	142	103.15	45.98	1	178
Renewable energy per capita (ton oil eqv.)	168	15.29	116.89	0	1506.21

Note: [a] $ktCO_2e$ = Kiloton of oil equivalent.

Table 4: Country-level data descriptive statistics (Investor countries)

Variable	Obs	Mean	Std. Dev.	Min	Max
Number of projects	34	54.11	132.52	0	720
Annual CO2 Abatement ($ktCO_2e$)	34	9299.81	23109.15	0	124150.1
Annual investment cost (Mill US$)	34	212	508	0	2670
Renewable energy per capita (ton oil eqv.)	34	6.64	18.57	0.22	106.03
Climate change impact vulnerability	34	27.50	12.72	1	50.38
Ease of Doing Business	34	37.39	33.70	2	139

Table 5: Descriptive statistics results for dyad-level variables in the analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
CDMI	2771	0.065	0.247	0	1
Number of Projects	2771	0.657	8.04	0	321
Total CO2 Abatement	2771	866.50	14820.18	0	672990.5
Annual CO2 Abatement	2771	112.80	1977.78	0	89793.5
Total Volume of Investment	2771	1.96E+07	3.35E+08	0	1.53E+10
Annual Volume of Investment	2771	2574199	4.45E+07	0	2.03E+09
*Trade*1	2771	0.00037	0.00101	0	0.02397
*Trade*2	2771	0.00090	0.00294	0	0.05724
hst_Averag GDP	2771	42233.17	79493.96	864.5967	407822.8
inv_Averag GDP	2771	289208.43	559055	5154.85	2914536
hst_Average Annual Energy Use	2771	33.03	95.20	0.885	790.7972
inv_Average Annual Energy Use	2771	82.97	129.83	1.69	640.80
hst_Ease of Doing Business	2771	98.90	42.00	1	178
inv_Ease of Doing Business	2771	37.46	33.26	2	139
hst_Governance	2771	-2.39	4.45	-12.45	11.34
inv_Governance	2771	7.91	4.74	-4.11	13.48
hst_Renewable Energy	2771	5516.84	12786.63	0	62220
inv_Renewable Energy	2771	113.96	353.60	1	1937
hst_Impact Vulnerability	2771	46.44	16.88	1	80.72
inv_Impact Vulnerability	2771	27.51	12.53	1	50.38

Note: See Appendix 2 for units of measurement. Interaction terms are not shown.

Table 6: Regression results for CDM Engagement (No interaction trms)

Equation	1	2	3
Estimation procedure	Logit	Probit	
Dependet variable	*CDM Engagement*	*CDM Engagement*	
			Marginal Effect[a]
hst_Average Annual Energy Use	2.04E-03*** (2.56)	1.24E-03*** (2.79)	0.0000495
inv_Average Annual Energy Use	8.79e-03*** (9.63)	4.62E-03*** (9.43)	0.0001845
hst_Ease of Doing Business	-9.47E-03*** (-3.33)	-4.59E-03*** (-3.06)	-0.0001833
inv_Ease of Doing Business	0.046 (0.59)	3.11E-02 (0.77)	0.000124
hst_Governance	0.077*** (2.77)	0.037*** (2.65)	0.0015142
inv_Governance	0.368*** (6.04)	0.185*** (5.93)	0.0073955
hst_Renewable Energy	1.26E-03*** (4.17)	6.02E-04*** (3.58)	0.000024
inv_Renewable Energy	-1.02E-03*** (-2.73)	-5.88E-04*** (-3.07)	-0.0000235
hst_Impact Vulnerability	4.06E-02*** (6.01)	1.90E-02*** (5.13)	0.0007592
inv_Impact Vulnerability	4.34E-02*** (5.18)	2.05E-02*** (5.13)	0.0008188
Trade1	209.61*** (2.70)	118.60*** (3.03)	4.726333
Constant	-10.05*** (-9.88)	-5.12*** (-9.96)	
Observations	2771	2771	
Log Likelihood	-461.01	-461.86	
LR	420.91***	419.21***	
Pseudo R^2	0.313	0.312	
Overall observed probability			0.065
Predicted Probability			0.016

In parentheses are t-values; *** (=0.01); ** (=0.05); * (=0.10).
[a]Marginal effect: the change in the probability for an infinitesimal change in each independent.

Table 7: Regression results for CDM projects cooperation level (Dependent variable is number of projects)

Equation	1[a]	2	3[b]	4
Estimation procedure	Poisson	Poisson	Poisson	Poisson
Dependet variable	*Number of Projects*	*Number of Projects*	*Number of Projects*	*Number of Projects*
hst_Averag GDP	7.47E-06*** (24.79)		8.35E-06*** (24.56)	
inv_Averag GDP	8.46E-07*** (20.03)		1.06E-06*** (20.24)	
hst_inv_Averag GDP			-1.07E-12*** (-6.16)	
hst_Average Annual Energy Use		2.98E-03*** (17.72)		3.18E-03*** (17.39)
inv_Average Annual Energy Use		7.95E-03*** (31.52)		8.60E-03*** (26.67)
host_inv_Average Annual Energy Use				-1.70E-06*** (-2.58)
hst_Ease of Doing Business	-9.92E-03*** (-10.71)	-7.81E-03*** (-7.62)	-8.40E-03*** (-5.99)	-7.47E-03 (-4.79)
inv_Ease of Doing Business	-0.016*** (-5.63)	-2.13E-02*** (-7.64)	-1.33E-02** (-1.96)	-1.92E-02*** (-2.96)
host_inv_Ease of Doing Business			-5.32E-05 (-0.76)	-2.55E-05 (-0.32)
hst_Governance	0.082*** (6.74)	0.160*** (14.08)	0.050 (0.99)	0.088* (1.78)
inv_Governance	0.301*** (15.42)	0.290*** (16.74)	0.292*** (14.34)	0.303*** (16.36)
host_inv_Governance			2.99E-03 (0.66)	6.47E-03 (1.45)
hst_Renewable Energy	1.09E-03*** (12.84)	1.56E-03*** (17.55)	1.12E-03*** (12.76)	1.66E-03*** (18.38)
inv_Renewable Energy	-8.31E-04*** (-5.25)	-1.89E-03*** (-10.94)	-3.65E-05 (0.17)	-0.01*** (-4.74)
host_inv_Renewable Energy			-1.28E-06*** (-4.72)	-1.35E-06*** (-4.50)
hst_Impact Vulnerability	0.074*** (25.03)	0.063*** (21.41)	0.114*** (14.11)	0.110*** (12.74)
inv_Impact Vulnerability	0.018*** (8.18)	0.023*** (9.20)	0.087*** (6.42)	0.104*** (7.18)
host_inv_Impact Vulnerability			-1.22E-03*** (-5.32)	-1.40E-03*** (-5.80)
Trade1	82.15*** (6.94)	35.95*** (2.96)	132.63*** (8.46)	54.82*** (3.37)
Constant	-8.72*** (-25.49)	-8.01*** (-25.38)	-11.26*** (-19.46)	-11.08*** (-18.52)
Observations	2771	2771	2771	2771
Log Likelihood	-2760.34	-2630.94	-2715.74	-2596.95
LR	10076.69***	10335.49***	10165***	10403.48***
Pseudo R^2	0.646	0.662	0.651	0.667

In parentheses are t-values; *** (=0.01); ** (=0.05); * (=0.10).

Note: [a]See Appendix 3, equation 1 for regression results of 3411 observations; [b]See Appendix 3, equation 2 for regression results of 3411 observations.

Table 8: Regression results for CDM projects cooperation level (Dependent variable is project CO_2 abatement level)

Equation	1	2	3	4	5	6
Estimation procedure	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit
Dependet variable	*Total CO2 Abatement*	*Total CO2 Abatement*	Ln(*Total CO2 Abatement)*	Ln(*Annual CO2 Abatement)*	*Total CO2 Abatement*	Ln(*Total CO2 Abatement)*
hst_Average Annual Energy Use	114.15*** (5.48)	114.90*** (5.53)	0.021*** (2.67)	0.018*** (2.64)	64.93*** (2.92)	0.022** (2.38)
inv_Average Annual Energy Use	218.51*** (7.95)	215.16*** (7.66)	0.090*** (8.33)	0.077*** (8.46)	175.52*** (6.48)	0.091*** (8.26)
host_inv_Average Annual Energy Use					0.554*** (4.49)	-1.03E-06 (-0.21)
hst_Ease of Doing Business	-195.70*** (-2.45)	-206.87*** (-2.60)	-0.095*** (-3.23)	-0.077*** (-3.09)	-228.42** (-2.21)	-0.113*** (-2.84)
inv_Ease of Doing Business	59.17 (0.27)	148.23 (0.68)	0.085 (1.10)	0.055 (0.84)	-151.26 (-0.39)	-0.029 (-0.21)
host_inv_Ease of Doing Business					1.77 (0.49)	0.001 (0.84)
hst_Governance	1435.95** (1.86)	1488.29** (1.93)	0.799*** (2.82)	0.657*** (2.72)	1946.27 (0.71)	0.996 (1.00)
inv_Governance	8680.39*** (5.13)	9433.50*** (5.51)	3.91*** (6.07)	3.17*** (5.83)	8067.71*** (5.00)	3.69*** (5.73)
host_inv_Governance					-50.55 (-0.20)	-0.020 (-0.23)
hst_Renewable Energy	24.98*** (2.91)	24.67*** (2.88)	0.011*** (3.65)	0.010*** (3.67)	29.69*** (3.63)	0.011*** (3.43)
inv_Renewable Energy	-27.68*** (-2.69)	-26.01*** (-2.53)	-0.010*** (-2.89)	-9.601E-3*** (-3.00)	-18.30* (-1.62)	-0.011*** (-2.76)
host_inv_Renewable Energy					-0.063*** (-2.89)	2.44E-6 (0.32)
hst_Impact Vulnerability	784.79*** (4.44)	751.08*** (4.28)	0.361*** (5.46)	0.314*** (5.55)	874.22* (1.91)	0.470*** (2.59)
inv_Impact Vulnerability	975.92*** (4.52)	1016.79*** (4.74)	0.430*** (5.36)	0.355*** (5.16)	1210.89* (1.74)	0.547** (2.08)
host_inv_Impact Vulnerability					-5.47 (-0.42)	-3.10E-03 (-0.61)
Trade1	6.91E06*** (3.82)			1651.83*** (2.50)	4.12E06*** (1.96)	1879.84** (2.29)
Trade2		1.85E6*** (3.46)	441.40** (2.04)			
Constant	-2.53E5*** (-8.58)	-2.60E5*** (-8.69)	-110.46*** (-9.37)	-93.66*** (-9.43)	-2.35E5*** (-6.42)	-111.55*** (-7.41)
Observations	2771	2771	2771	2771	2771	2771
Uncensored obs.	182	182	182	182	182	182
Log Likelihood	-2477.73	-2477.86	-1113.53	-1083.83	-2467.98	-1112.32
LR	431.28***	431.04***	422.78***	426.03***	450.79***	425.21***
Pseudo R^2	0.080	0.080	0.159	0.164	0.083	0.160

In parentheses are t-values; *** (=0.01); ** (=0.05); * (=0.10).

Table 9: Regression results for CDM projects cooperation level (Dependent variable is Volume of investment)

Equation	1[a]	2[b]	3	4	5
Estimation procedure	Tobit	Tobit	Tobit	Tobit	Tobit
Dependet variable	*Total Volume of Investment*	*Annual Volume of Investment*	*Ln(Total Volume of Investment)*	*Ln(Annual Volume of Investment)*	*Ln(Total Volume of Investment)*
hst_Averag GDP					6.30E-05** (2.56)
inv_Averag GDP					2.09E-05*** (8.25)
hst_inv_Averag GDP					1.99E-11 (1.07)
hst_Average Annual Energy Use	2.92E06*** (6.22)	3.90E05*** (6.25)	0.034*** (2.52)	0.033*** (2.63)	
inv_Average Annual Energy Use	5.43E06*** (8.69)	7.22E05*** (8.68)	0.152*** (8.41)	0.139*** (8.32)	
hst_Ease of Doing Business	-5.26E06*** (-2.90)	-7.05E05*** (-2.93)	-0.152*** (-3.06)	-0.145*** (-3.20)	-0.179*** (-2.70)
inv_Ease of Doing Business	3.32E06 (0.67)	4.46E05 (0.68)	0.116 (0.89)	0.134 (1.13)	0.108 (0.46)
hst_inv_Ease of Doing Business					1.81E-03 (0.87)
hst_Governance	3.91E07** (2.22)	5.10E06** (2.18)	1.30*** (2.73)	1.22*** (2.82)	1.43 (0.79)
inv_Governance	2.19E08*** (5.62)	2.90E07*** (5.62)	6.29*** (5.86)	6.04*** (6.09)	6.97*** (5.93)
host_inv_Governance					-0.034 (-0.21)
hst_Renewable Energy	5.63E05*** (2.87)	7.52E04*** (2.88)	0.019*** (3.55)	0.017*** (3.55)	0.012* (1.83))
inv_Renewable Energy	-7.55E05*** (-3.12)	-1.00E05*** (-3.11)	-0.019*** (-3.01)	-0.017*** (-2.92)	-0.004 (0.54)
host_inv_Renewable Energy					1.05E-05 (0.76)
hst_Impact Vulnerability	1.76E07*** (4.37)	2.3026*** (4.33)	0.626*** (5.59)	0.561*** (5.51)	0.763*** (2.59)
inv_Impact Vulnerability	2.51E07*** (5.09)	3.33E07*** (5.09)	0.700*** (5.17)	0.663*** (5.37)	0.907** (2.02)
host_inv_Impact Vulnerability					-4.77E-03 (-0.58)
Trade1			3105.00** (2.35)		2106.44 (1.40)
Trade2				657.55** (1.98)	
Constant	-5.99E9*** (-8.79)	-7.95E7*** (-8.78)	-178.73*** (-9.11)	-166.58*** (-9.19)	-191.54 (-7.48)
Observations	2771	2771	2771	2771	2771
Uncensored obs.	182	182	182	182	182
Log Likelihood	-4306.05	-3938.14	-1207.96	-1191.85	-1207.47
LR	423.80	424.20	420.42***	420.13***	421.38***
Pseudo R^2	0.047	0.051	0.148	0.149	0.148

In parentheses are t-values; *** (=0.01); ** (=0.05); * (=0.10).

Note: See Appendix 3, equation 3 for regression results of 2856 observations; See Appendix 3, equation 4 for regression results of 2856 observations.

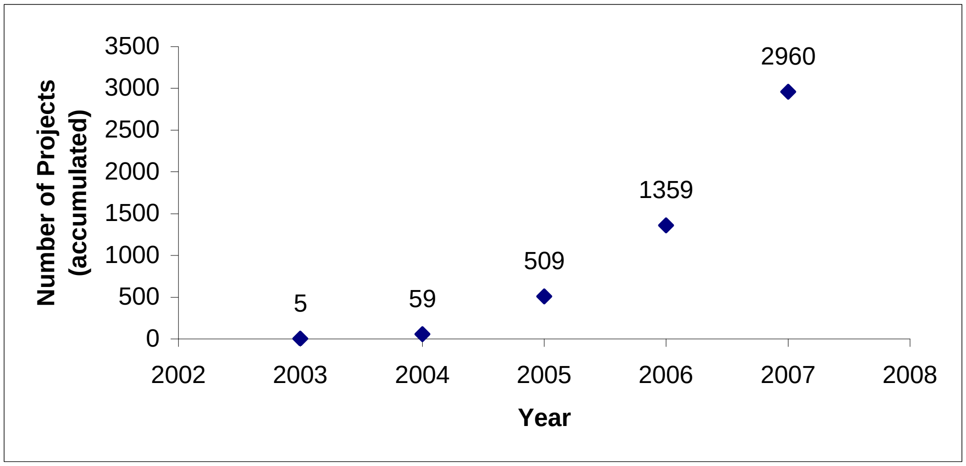

Figure 1: Accumulative number of CDM submitted projects 2003-2007.

APPENDIX 1: METHODOLOGY FOR THE DATA COLLECTION ON THE CAPITAL COST DATA FROM CLEAN DEVELOPMENT MECHANISM PROJECT ACTIVITY[13]

Reporting project capital cost data is not required in for CDM registration, but the information is sometimes used to demonstrate additionality. One consequence is that the way the information is presented in official CDM documents is not standardized and some interpretation is required.

Of those PDDs that contain capital cost information, it is often reported as "Capital costs" or "fixed costs" for the project, and as a single number either in host country currency units or USD. From what is reported, capital cost in the CDM PDDs generally includes: (1) procurement of any plant and/or machinery dedicated to the realization of the CDM project, (2) construction and civil works, and (3) engineering consultation (non-ongoing). In some cases, the following were included in the capital costs: (1) Costs incurred for the validation, registration, and verification of the project as a CDM project, (2) Contingency and margin money for working capital, (3) interest during construction, and (4) licenses.

Unfortunately, it was not possible to disaggregate the costs as only one (all inclusive) number was reported. In some cases, project participants reported all costs, including variable costs in a table. For these cases, capital cost had to be reconstituted into a single number in order to record it into the dataset.[14]

Methods in obtaining capital cost data

As stated above, information on project costs is sometimes used in the demonstration of "additionality" of the CDM project. The section of the PDD where participants prove the additionality of the project is section B.5.

In each of the PDDs, this section was thoroughly reviewed to determine if capital cost data was included. In addition, the entire PDD was searched using key words such as USD, $, investment, cost, capital, and currency acronym for the host country (ex: for projects in china, key words included, CNY, RMB, yuan).

---

[13] We thank Stephen Seres for helping with this Annex.

[14] Most PDDs provided one single capital cost value which generally included construction, equipment, and engineering costs. Where detailed tables were included, only the values for construction, equipment, and engineering costs were summed to produce a single value for the dataset with hopes at maintaining comparability.

All cost data was recorded in the spreadsheet in the currency units used in the PDD. All cost data were converted into USD using the spot exchange rate on the 20th of November 2007. The exchange rates used were included in the dataset.

Perspective in capital cost data

It may be important to note two facts with regard to the capital cost data from CDM project activity.

First, it should not be assumed that the CDM projects have been implemented yet and so capital cost outlays may not have occurred. The CDM project data represents all projects that have been put forth for validation and registration. This may, and often does, occur prior to commitments on capital purchases have been made. However, it is largely expected that these projects will be implemented.

Second, it should not be assumed that the reported capital expenditures on CDM projects are solely attributable to the CDM. In many cases, capital expenditures would have taken place in its absence. For instance, wind farm and hydro projects are implemented to increase the host country's power generation capacity. In the absence of the CDM, it is likely that capital expenditures would have taken place regardless, in order to increase the host country's power generation capacity, albeit with a different technology and less of a capital outlay. However, for certain project types, where there is no revenue stream other than CDM credits, i.e. landfill gas and animal waste flaring projects, it would be fair to assume that the capital cost expenditures are solely attributable to the CDM.

APPENDIX 2: DEFINITION OF VARIABLES USED IN THE REGRESSION ANALYSES

Variable		Description	Unit of Measurement
Ease of Doing Business	*EDB*	Ease of doing business, a relative ranking of the countries reflecting the state of business regulation	Smaller value indicates less favorable business environment
CDM Incidence	*CDMI*	A dichotomous variable with 0 if there are no, and 1 if there are any number of CDM dyad projects.	0 or 1
Avr Annual Energy Use	*ENR_AVG*	Average annual energy use over t he period 1960-2003	Million tons of oil equivalent
Annual Per Capita Energy Use	*ENR_PC*	Annual per capita energy consumption	Tons of oil equivalent
GDP	*GDP_TOT*	Total gross domestic product for the period 1960-2003.	Million US $ (constant 2000)
GDP per Capita	*GDP_PC*	Gross domestic product per capita for the period 1960-2003.	Thousand US $ (constant 2000)
Average GDP	*GDP_AVG*	Average annual gross domestic product for the period 1960-2003	Million US $ (constant 2000)
Governance	*GOVR*	Indicator reflecting the overall governance level, a principal component product of 6 governance indicators	Smaller value indicates poorer level of governance
Impact Vulnerability	*IVUL*	Impact vulnerability index (reflecting country vulnerability in terms of various impacts of climate change)	Scale of 1 to 100 (1= lowest, 100=highest)
Number of Project	*NPRJ*	Number of CDM projects	
Nonrenewable Energy	*NREN*	Non-renewable energy resources (total) available per capita	Million tons of oil equivalent
Renewable Energy	*REN*	Renewable energy resources (annual) available per capita.	Million tons of oil equivalent
Total CO2 Abatement	*TCO2_TOT*	Total amount of CO2 abatement (CERs) until 2012.	Kiloton of oil equivalent
Annual CO2 Abatement	*TCO2_YR*	Annual amount of CO2 abatement (CERs) until 2012.	Kiloton of oil equivalent
Trade1	TRD_1	Total trade (the sum of the volume of bilateral imports and exports) between the host and investor countries as a fraction of the sum of the countries' GDPs	Share
Trade2	TRD_2	Total trade (the sum of the volume of bilateral imports and exports) between the host and investor countries as a fraction of their trade with the rest of the world.	Share
Volume of Investment	*VINV*	Volume of investment in CDM projects: *_TOT* reflecting total investment and *_YR* reflecting annual investment	US $ (constant 2000)
*hst_**	*hst_**	Variable related to the host country	* represents the variables described above
*inv_**	*inv_**	Variable related to the investor country	* represents the variables described above
*hst_inv_**	*hst_inv_**	An interaction term	* represents the variables described above

APPENDIX 3: REGRESSION RESULTS WITH AN EXTENDED NUMBER OF OBSERVATIONS.

Equation	1	2	3	4
Estimation procedure	Poisson	Poisson	Tobit	Tobit
Dependet variable	Number of Projects	Number of Projects	Total Volume of Investment	Annual Volume of Investment
hst_Averag GDP	8.68E-06*** (29.53)	9.63E-06*** (29.04)		
inv_Averag GDP	8.43E-07*** (20.07)	1.06E-06*** (20.96)		
hst_inv_Averag GDP		-1.18E-12*** (-6.93)		
hst_Average Annual Energy Use			3076.01*** (6.54)	409.74*** (6.57)
inv_Average Annual Energy Use			5389.33*** (8.70)	715.44*** (8.70)
hst_Ease of Doing Business	-8.90E-03*** (-9.64)	-7.41E-03*** (-5.35)	-4.70E06*** (-2.60)	-6.32E05*** (-2.63)
inv_Ease of Doing Business	-0.016*** (-5.59)	-1.4E-02*** (-2.16)	3.37E06 (0.69)	4.52E05 (0.69)
hst_inv_Ease of Doing Business		-4.19E-5 (-0.61)		
hst_Governance	0.042*** (3.73)	0.042 (0.89)	3.15E07* (1.81)	4.09E06* (1.77)
inv_Governance	0.300*** (15.46)	0.286*** (14.23)	2.18E08*** (4.65)	2.89E07*** (2.72)
host_inv_Governance		1.64E-04 (0.04)		
hst_Renewable Energy	8.63E-04*** (10.63)	8.81E-04*** (10.47)	5.32E05*** (2.70)	7.11E04*** (2.72)
inv_Renewable Energy	-8.38E-04*** (-5.30)	-9.82E-06 (-0.05)	-7.44E05*** (-3.10)	-9.88E04*** (-3.10)
host_inv_Renewable Energy		-1.23E-06*** (-4.63)		
hst_Impact Vulnerability	0.061*** (23.68)	0.099*** (12.99)	1.50E07*** (3.87)	1.97E06*** (3.83)
inv_Impact Vulnerability	0.018*** (8.29)	0.083*** (6.38)	2.49E07*** (5.09)	3.30E06*** (5.20)
host_inv_Impact Vulnerability		-1.15E-03*** (-5.24)		
Trade1	85.71*** (7.32)	146.45*** (9.28)		
Constant	-8.29*** (-24.56)	-10.68*** (-19.28)	-5.94E09*** (-8.79)	-7.87E08*** (-8.79)
Observations	3411	3411	2856	2856
Uncensored obs.			182	182
Log Likelihood	-2898.2	-2849.64	-4313.30	-3945.42
LR	10573.85***	10670.97***	419.20***	419.69***
Pseudo R^2	0.646	0.651	0.046	0.050

In parentheses are t-values; *** (=0.01); ** (=0.05); * (=0.10).